REMARKS

Favorable reconsideration of this application is respectfully requested in view of the following remarks.

The claims currently pending in this application are Claims 1-18, with Claims 1 and 8 being the only independent claims.

Appreciation is expressed to Examiner Chin for the indication that Claims 2-4 and 16-18 would be allowable if rewritten in independent form.

By way of this Amendment, Claim 9 has been amended without narrowing the claim scope to change the phrase "a steering angle" to –said steering angle—in accordance with the Examiner's helpful suggestion.

The Official Action also indicates that the wording in Claims 3 and 17 is vague and indefinite, and contextually unclear. However, upon studying the wording in Claims 3 and 17, the Examiner's concern is not fully understood. These claims recite that the reference aligning torque setting means sets the reference aligning torque by approximating a characteristic of the aligning torque estimated by the aligning torque estimation means against the wheel factor provided by the wheel factor providing means to a linear characteristic of the reference aligning torque which includes at least the origin. That is, a characteristic of the aligning torque relative to the wheel factor is approximated to a linear characteristic of the reference aligning torque which includes at least the origin. In addition, the reference aligning torque setting means sets the reference aligning torque on the basis of this linear characteristic of the reference aligning torque. This claim wording is consistent with the description at various places in the application. For example, the discussion which begins on page 29 of the application and extends to page 30 describes how a

characteristic of the aligning torque with respect to the wheel factor is approximated to a linear characteristic of the reference aligning torque that includes the origin O, with the reference aligning torque being set on the basis of the linear characteristic of the reference aligning torque. Other embodiments of the disclosed subject matter include related descriptions.

Thus, it is believed that the wording in Claims 3 and 17 particularly points out and distinctly claims the subject matter at issue, and thus complies with the requirements of the second paragraph of 35 U.S.C. § 112. In the event the Examiner still has concerns regarding the language in Claims 3 and 17, the Examiner is kindly asked to contact the undersigned to discuss this issue in more detail. For at least the reasons set forth above, withdrawal of the claim rejection based on the second paragraph of 35 U.S.C. § 112 is respectfully requested.

The Official Action sets forth a rejection of independent Claims 1 and 8 based on the disclosure contained in U.S. Application Publication No. 2002/0011093 to *Matsuno*. That rejection is respectfully traversed for at least the following reasons.

Independent Claim 1 is directed to an apparatus for estimating a road condition for use in a vehicle having steering control means for actuating a device mechanically independent of a manually operated steering member to steer each wheel. The apparatus comprises reaction torque detection means for detecting a reaction torque when at least a wheel of the vehicle is steered by the steering control means, aligning torque estimation means for estimating an aligning torque produced on the wheel on the basis of the reaction torque detected by the reaction torque detection means, wheel factor providing means for providing at least one of wheel factors including a side force and a slip angle applied to the wheel, and a grip factor

estimation means for estimating a grip factor of at least a tire of the wheel in accordance with the relationship between the aligning torque estimated by the aligning torque estimation means and the wheel factor provided by the wheel factor providing means.

The other independent claim in this application, Claim 8, is directed to a vehicle motion control apparatus provided with an apparatus for estimating a road condition for use in a vehicle having steering control means for actuating a device mechanically independent of a manually operated steering member to steer each wheel. As set forth in Claim 8, the vehicle motion control apparatus comprises reaction torque detection means for detecting a reaction torque when at least a wheel of the vehicle is steered by the steering control means, aligning torque estimation means for estimating an aligning torque produced on the wheel on the basis of the reaction torque detected by the reaction torque detection means, wheel factor providing means for providing at least one of wheel factors including a side force and a slip angle applied to the wheel, and grip factor estimation means for estimating a grip factor of at least a tire of the wheel in accordance with a relationship between the aligning torque estimated by the aligning torque estimation means and the wheel factor provided by the wheel factor providing means. The steering control means steers the wheel to provide a steering angle thereof on the basis of the grip factor estimated by the grip factor estimation means.

Discussing the disclosure in *Matsuno*, the Official Action notes that *Matsuno* describes a road friction coefficient setting unit 15. This road friction coefficient setting unit 15 sets the road friction coefficient μ in accordance with the Fig. 5 characteristics map for the road friction coefficient of a front-wheel slip angle and a

self-aligning torque. The front wheel slip angle αf and the self-aligning torque Tsa are determined through experiments or calculations. The Official Action also indicates that the road friction coefficient setting unit 15 corresponds to the claimed grip factor estimation means which estimates the grip factor of at least a tire of the wheel. However, as discussed below in more detail, that is not the case because the road friction coefficient μ set by the road friction coefficient setting unit 15 is quite different from grip factor of the wheel tire that is estimated by the grip factor estimation means recited in Claims 1. and 8

The coefficient of friction or friction coefficient mentioned in *Matsuno* is a known term. As shown in the excerpt from the Automotive Handbook published by Robert Bosch GmbH attached as Appendix 1, the static coefficient of friction between the tires and the road surface, also referred to as the tire-road-interface friction coefficient, is determined by the vehicle speed, the condition of the vehicle tires and the condition or state of the road surface. The excerpt from the Automotive Handbook includes a table identifying the coefficient of static friction for tires on various types of road surfaces taking into account variations in the vehicle speed and the tire condition. Thus, by way of example, the coefficient of friction (coefficient of static friction) μ_{HF} of a new tire on a vehicle traveling at 50 km/h on a road surface under dry conditions is 0.85, while the coefficient of friction μ_{HF} of the same tire on a vehicle traveling at the same speed on an iced road is 0.1 or less.

In contrast, as discussed at, for example, lines 21-25 of page 8 of the present application and with reference to Figs. 2-4, the term grip factor as used in the present application refers to the gripped level of the tire on the road surface in the lateral direction of the vehicle tire. The grip factor refers to the level of grip of the

vehicle tire against the road surface in the lateral direction. Thus, as shown on the attached Appendix 2, it is possible for a vehicle tire to possess a high grip factor on a road surface having a relatively low coefficient of friction as indicated at A in the graph of attached Appendix 2. Alternatively, it is possible for a vehicle tire to have a low grip factor on a road surface possessing a relatively high coefficient of friction as indicated at B in the graph of attached Appendix 2.

By way of example, and with reference once again to the table in attached Appendix 1, the coefficient of friction μ_{HF} of a new tire on a vehicle traveling on an iced road surface is 0.1 or less. As noted, this coefficient of friction is based on the vehicle speed, the condition of the vehicle tires and the state of the road surface. However, in connection with the estimated grip factor, it is the gripped level of the vehicle tire that is estimated. Thus, even if the vehicle tire is moving on an iced surface, insofar as the vehicle tire is gripped against the iced road surface, the grip factor is determined to be "1", indicating an approximately completely gripped condition of the tire against the iced road surface. The lower the gripped level of the is decreased, the smaller the estimated value for the grip factor.

Because the grip factor is estimated based on the gripped level of the vehicle tire, the grip factor itself can be used as a state variable or control variable for a control system. On the other hand, the coefficient of friction itself cannot be used as a state variable or a control variable that is directly employed in a control system. The coefficient of friction may be used such that the control is changed on the basis of the coefficient of friction, or a threshold value or gain is adjusted or modified on the basis of the coefficient of friction.

Based on at least the foregoing discussion, it is to be understood that the grip factor estimated by the grip factor estimating apparatus at issue here is quite different from the concept of coefficient of friction set by the road friction coefficient setting unit 15 discussed in *Matsuno*. To better highlight this distinction, Claims 1 and 8 have been amended to recite that the grip factor indicates the grip level of the tire in a lateral direction to the wheel.

Matsuno describes a road friction coefficient estimating apparatus that is designed to estimate the road friction coefficient over a wide driving range while at the same time reducing the noise associated with the sensor. *Matsuno* describes estimating the road friction coefficient according to the Fig. 5 characteristics map for the road friction coefficient of a front-wheel slip angle and a self-aligning torque. The front wheel slip angle and the self-aligning torque are previously determined through experiments or calculation. As represented in the Fig. 5 map, when the front wheel slip angle is constant, the larger the road friction coefficient results in a larger self-aligning torque. The road friction coefficient setting unit 15 is prohibited from setting the road friction coefficient when the vehicle speed is very low. This is because the steering torque is highly affected and so there is a possibility that precise estimation of the road friction coefficient is difficult. Thus, *Matsuno* is specifically concerned with estimating the road friction coefficient based on the self-aligning torque and the front-wheel slip angle. However, *Matsuno* is not at all concerned with estimating the grip factor of a vehicle wheel and does not utilize a grip factor estimation means for estimating the grip factor of a wheel tire as recited in Claims 1 and 8. Thus, Claims 1 and 8 cannot be said to be anticipated by the disclosure in *Matsuno*.

The other documents cited in the Official Action are also not concerned with, and do not disclose, estimating the grip factor of a wheel tire. For example, European Patent Application Publication No. 0 323 066 to *Yopp* discloses an automotive system for dynamically determining road adhesion. The system is designed to determine road adhesion independent of tire wear and the type of tire employed. As discussed in the second full paragraph of column 1 of *Yopp* the term "road adhesion" refers to the friction developed between the vehicle tire and the road surface. The disclosed system determines road adhesion based on the road wheel turning angle, the vehicle speed and the steering force. More specifically, *Yopp* describes that data from a vehicle speed measuring device 22, a road wheel turn angle measuring device 24 and a steering force measuring device 26 are inputted to a CPU 16. This data is then used by the CPU in conjunction with the algorithm shown in Fig. 4 to determine the actual road adhesion value. As discussed near the top of column 9 of *Yopp*, the detection of the road adhesion is used to provide a warning to the driver. That is, if an extremely low level of road adhesion is determined, a driver warning device is activated to advise the driver of the low road adhesion condition. Thus, the disclosure in *Yopp* is once again not concerned with estimating the grip factor indicating the gripped level of the tire on the road surface in the lateral direction of the vehicle tire, but rather is concerned with road adhesion or coefficient of friction in much the same way as *Matsuno*.

The other document cited in the Official Action, U.S. Application Publication No. 2003/0028308 to *Ishikawa et al.* discloses an anti-skid brake control apparatus for a vehicle provided with left and right road friction coefficient estimating sections which calculate the left and right estimated road surface friction coefficients. These

estimated road surface friction coefficients are calculated based on a relationship between a pressure decrease control time during one cycle and a maximum wheel acceleration during the pressure decreased time. However, like the disclosures in *Matsuno* and *Yopp*, *Ishikawa et al.* does not disclose an apparatus that estimates the grip factor indicating the gripped level of the tire on the road surface in the lateral direction of the vehicle wheel as set forth in Claims 1 and 8, and does not disclose a steering control means which steers the wheel to provide a steering angle based on such grip factor estimated by a grip factor estimation means as recited in independent Claim 8. It is thus respectfully submitted that the combined disclosures contained in *Matsuno*, *Yopp* and *Ishikawa et al.* would not have directed one to do that which is defined in independent Claims 1 and 8 as the invention. Accordingly, withdrawal of the rejections of record and allowance of this application are earnestly solicited.

Should any questions arise in connection with this application or should the Examiner believe that a telephone conference with the undersigned would be helpful in resolving any remaining issues pertaining to this application, the undersigned respectfully requests that he be contacted at the number indicated below.

Respectfully submitted,

BURNS, DOANE, SWECKER & MATHIS, L.L.P.

Date: December 16, 2004

By: Matthew L Schneider
Matthew L. Schneider
Registration No. 32,814

P.O. Box 1404
Alexandria, Virginia 22313-1404
(703) 836-6620

Motive force
The higher the engine torque M and overall transmission ratio i between engine and driven wheels, and the lower the power-transmission losses, the higher is the motive force F available at the drive wheels.

$$F = \frac{M \cdot i}{r} \cdot \eta \text{ or } F = \frac{P \cdot \eta}{v}$$

η Drivetrain efficiency level
(lengthways engine $\eta \approx 0.88 \ldots 0.92$)
(transverse engine $\eta \approx 0.91 \ldots 0.95$)

The motive force F is partially consumed in overcoming the running resistance F_W. Numerically higher transmission ratios are applied to deal with the substantially increased running resistance encountered on gradients (gearbox).

Vehicle and engine speeds

$$n = \frac{60 \cdot v \cdot i}{2 \cdot \pi \cdot r}$$

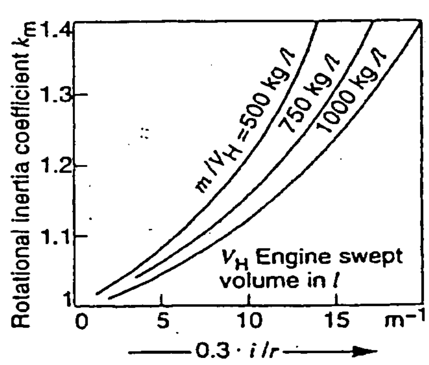
or with v in km/h:

$$n = \frac{1000 \cdot v \cdot i}{2 \cdot \pi \cdot 60 \cdot r}$$

Acceleration
The surplus force $F - F_W$ accelerates the vehicle (or retards it when F_W exceeds F).

$$a = \frac{F - F_W}{k_m \cdot m} \quad \text{oder } a = \frac{P \cdot \eta - P_W}{v \cdot k_m \cdot m}$$

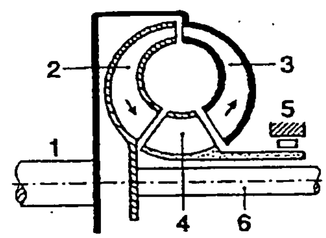
Determining the rotational inertia coefficient k_m



The rotational inertia coefficient k_m, compensates for the apparent increase in vehicle mass due to the rotating masses (wheels, flywheel, crankshaft, etc.).

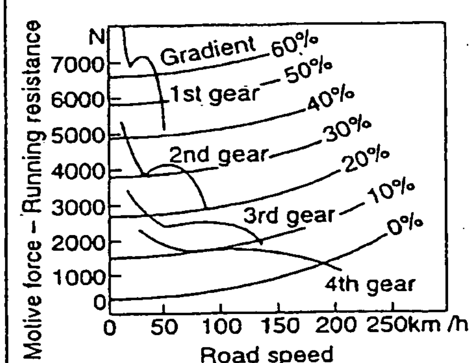
Motive force and road speed on vehicles with automatic transmissions
When the formula for motive force is applied to automatic transmissions with hydrodynamic torque converters or hydrodynamic clutches, the engine torque M is replaced by the torque at the converter turbine, while the rotational speed of the converter turbine is used in the formula for engine speed.

Hydrodynamic converter
1 Power, 2 Turbine, 3 Pump, 4 Stator, 5 One-way clutch, 6 Output.



The relationship between $M_{Turb} = f(n_{Turb})$ and the engine curve $M_{Mot} = f(n_{Mot})$ is determined using the performance curve of the hydrodynamic converter (p. 651).

Running diagram for car with automatic transmission and hydrodynamic trilok converter under full throttle



Adhesion to road surface

Coefficients of static friction for pneumatic tires on various surfaces

Vehicle speed km/h	Tire condition	Road condition Dry	wet Water approx. 0.2 mm deep	Heavy rainfall Water approx. 1 mm deep	Puddles Water approx. 2 mm deep	Ice (Black ice)
		Coefficient of static friction μ_{HF}				
50	new	0.85	0.65	0.55	0.5	0.1 and less
	worn[1])	1	0.5	0.4	0.25	
90	new	0.8	0.6	0.3	0.05	
	worn[1])	0.95	0.2	0.1	0.05	
130	new	0.75	0.55	0.2	0	
	worn[1])	0.9	0.2	0.1	0	

The static coefficient of friction (between the tires and the road surface), also known as the tire-road-interface friction coefficient, is determined by the vehicle's speed, the condition of the tires and the state of the road surface (see table above). The figures cited apply for concrete and tarmacadam road surfaces in good condition. The coefficients of sliding friction (with wheel locked) are usually lower than the coefficients of static friction.

Special rubber compounds providing friction coefficients of up to 1.8 are employed in racing tires.

The maxima for acceleration and uphill driving, and for retardation and downhill braking, are provided on page 337.

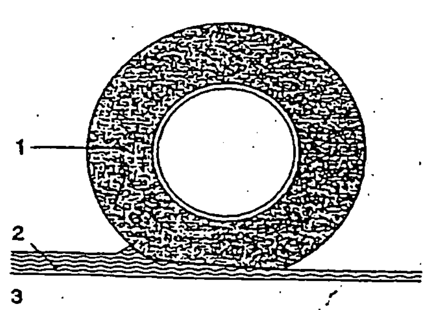
Aquaplaning

Aquaplaning, has a particularly dramatic influence on the contact between tire and road surface. It describes the state in which a layer of water separates the tire and the (wet) road surface. The phenomenon occurs when a wedge of water forces its way underneath the tire's contact patch and lifts it from the road.

[1]) Worn to tread depth of 1,6 mm (minimum allowed under Paragraph 36.2, StVZO).

The tendency to aquaplane is dependent upon such factors as the depth of the water on the road surface, the vehicle's speed, the tread pattern, the tread wear, and the load pressing the tire against the road surface. Wide tires are particularly susceptible to aquaplaning. It is not possible to steer or brake an aquaplaning vehicle, as its front wheels will have ceased to rotate, meaning that neither steering inputs nor braking forces can be transmitted to the road surface.

Aquaplaning
1 Tires, 2 Wedge of water, 3 Road surface.



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Department for Technical Information
(KH/VDT).
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Editor in chief:
Dipl.-Ing.(FH) Horst Bauer.

Editors:
Ing.(grad.) Arne Cypra,
Dipl.-Ing. (FH) Anton Beer,
Dipl.-Ing. Hans Bauer.

Production management:
Joachim Kaiser.

Layout:
Dipl.-Ing.(FH) Ulrich Adler,
Joachim Kaiser.

Translation:
Editor in chief:
Peter Girling
Translated by:
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Dr. W.-D. Haehl GmbH, Stuttgart
Member of the ALPNET Services Group
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Zahnradfabrik Friedrichshafen AG, Friedrichshafen.
Source of information for motor-vehicle specifications: Automobil Revue Katalog 1995.

(4.2)

Foreword to the 4th Edition

This "Automotive Handbook" is a handy, concise, pocket-sized technical reference manual. Its primary purpose is to provide the automotive engineer and mechanic, as well as all those interested in technical matters, with a wealth of reliable technical data and an insight into present-day state-of-the-art automotive technology in Germany. With this assignment in mind, the scope of the theoretical chapters dealing with **passenger cars and commercial vehicles**, as well as the remaining contents, have been kept to the practical and necessary level.

Within the framework of a pocketbook, it is impossible to present detailed coverage of individual technical subjects. On the other hand, bearing in mind the very wide range of readers, we did not want to dispense with generally applicable topics and data.

We recommend that you leaf through this "Automotive Handbook" before attempting to use it. This will prove to be a help when you subsequently want to refer to a particular subject.

The addition of new technical subjects and the expansion and up-dating of existing material are reflected in the fact that this 4th Edition is 40 pages longer than its predecessor.

Similar to the 2nd and 3rd Editions, this 4th Edition was to a great extent revised and up-dated by specialists from the Bosch Group, but also by experts from other companies. At this point we would like to express our appreciation to all concerned.

The editors

For your information:

Compared to the 3rd Edition, we have up-dated the following subjects:
Strength of materials, acoustics
Electronics:
Microhybrids, circuits, pc-board techniques, sensors, actuators
Materials science:
Basics, materials, lubricants, fuels, brake fluids, antifreeze
Joining and bonding techniques:
Punch riveting
Tribology
Internal-combustion engines:
Reciprocating-piston engines
Engine management (spark-ignition engines):
Spark plugs, electric fuel pumps, fuel supply (L-Jetronic),
Motronic, exhaust emissions, LPG systems
Engine management (diesel engines):
Axial/radial plunger distributor pumps, unit pump system, unit-injector system, common-rail, nozzles and nozzle-holders, exhaust emissions, auxiliary starting devices
Electric drives
Drivetrain:
ASR for pass. cars and commercial vehicles
Braking systems:
Basics, brake-circuit configurations, ABS for passenger cars, ABS and ELB for commercial vehicles
Lighting
Reflectors, PES-PLUS headlamps, Litronic, lights and lamps
Theft-deterrent systems
Communication/information systems:
Car radio, parking systems, navigation systems, mobile radio,
Board Information Terminal (BIT)
Safety systems:
Front and side airbag systems
Comfort and convenience systems:
Power sunroofs and power windows, seat and steering-column adjustment
Automotive electrical system:
Circuit diagrams, energy supply, CAN
Electromagnetic compatibility (EMC)
Motor-vehicle specifications
Following subjects have been introduced:
Vehicle dynamics control (VDC)
and the following have been dropped:
Rear-wheel steering, vehicle-monitoring system (Check-Control), trip computer, tire-pressure monitoring system (RKS)